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ETHER versus CYCLOPROPANE

(A STATISTICAL COMPARISON OF CIRCULATORY COMPLICATIONS AFTER ABDOMINAL OPERATIONS)

BY

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THE ultimate test of any anæsthetic agent or technique is the condition of the patient after operation. Cyclopropane has now been widely used as an anæsthetic agent for eight years. From its earliest days it was evident that it lacked the potency of ether as regards the inhibition of reflexes, and in the matter of the production of that muscular and peritoneal flaccidity which is commonly referred to as "relaxation." In 1934 Waters and Schmidt[1] wrote of it: "In the lower part of the abdomen . . . satisfaction has been complete for surgeon and anæsthetist. Relaxation is ample. For upper abdominal work . . . noticeable defect in the relaxation has been evident in many cases." It was pointed out in the same paper that when high concentrations of the agent are used in order to obtain effective conditions of work for the surgeon sudden disorders of cardiac rate and rhythm are often encountered.

The majority of anæsthetists have felt that in view of the pharmacological evidence, which has been the work chiefly of Meek and of Robbins and their associates, and has been ably summarized by the latter in his recent book,[2] the

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occurrence of arrhythmia during anæsthesia was to be regarded as a sign of danger. It was their concensus that the concentration of the agent should be lowered at once when an arrhythmia was observed.[3] In 1940 Guedel[4] put forward the view that "cardiac arrhythmia occurring during cyclopropane anæsthesia, although they must be respected, need not be feared. They are probably reflex in origin and subject to the same influences as other reflexes during anæsthesia.... They occupy a fairly definite range in cyclopropane anæsthesia, and anæsthesia can be conducted either above or below that range of concentration of cyclopropane." More recently Thienes, Greeley, and Guedel[5] have said that cyclopropane does not seem to be toxic to the heart except in the presence of anoxaemia.

It has long been recognized that circulatory complications in the post-operative period occur more frequently after the use of cyclopropane than after that of ether.[1] Kurtz *et al.*[6] showed that arrhythmiae seen during anæsthesia with any agent often persisted for some time in the post-operative period. Hewer[7] summarized the position in 1939 by saying: "The figures for respiratory complications and vomiting were definitely in favour of cyclopropane, but those for circulatory complications and post-operative deaths told against the gas."

Nevertheless a number of anæsthetists still feel that this view should be conditioned by the fact that cyclopropane has often been the agent chosen for patients whose circulatory systems were in poor condition before operation. They have thought that a patient who has been deeply anæsthetized with ether is more liable to remote circulatory sequelæ than a patient who has been similarly anæsthetized with cyclopropane. This view was, however, founded on recollection of different patients, surgeons, institutions, and personnel, and not on recorded fact. To test this hypothesis this survey of post-operative circulatory complications was undertaken. Upon its result rests the question of whether or not, and irrespective of the complications encountered *during* anæsthesia, cyclopropane is as sound a choice of agent as ether for abdominal operations.

The records of the Department of Anæsthesia of the Univer-

sity of Wisconsin make it possible to limit the number of uncontrollable variables in such a study. The patients were all treated by the same teams of surgeons and anæsthetists, and these are composed of individuals of varying degrees of experience. The records of all the abdominal operations performed in the Wisconsin General Hospital during the years 1938, 1939, and 1940 have been investigated by means of the system of Hollerith punched cards, which has been described elsewhere.[8, 14] The records have been kept in accordance with the suggestions put forward by the Committee on Records and Statistics of the American Society of Anæsthetists. In the course of the three years in question, cyclopropane has been more frequently used than ether as the agent of choice in abdominal cases. This choice has been made, at the time, by the individual administering the agent; and it has depended on his opinion of the needs of that particular patient. In 1938 ether was used in the majority of abdominal cases; in 1939 ether was used in 362 cases and cyclopropane in 483; whereas in 1940 ether was used 240 times and cyclopropane 640 times. The results of this work, then, have not been conditioned by a preferential use of either agent. Those few cases in which anæsthesia was obtained by the use of regional methods, or by means of some other agent have been excluded. Where one agent was used to supplement another the case has been excluded unless it was clear that one agent was used only for induction. The abdominal interventions were chosen for this survey because they require deeper anæsthesia than other operations for their smooth performance. Since it is usually conceded that operations in the epigastrium require more profound anæsthesia and involve a greater strain on the patient's circulatory system, the operations above the umbilicus have been considered separately from the "lower abdominal" interventions. In order that results in patients of similar condition might be compared, the patients were divided into: (1) those with normal circulatory systems before operation, and (2) those with abnormal circulatory systems. Each of these categories was then subdivided into "physical states" according to the classification laid down by the Committee on Records and Statistics of the American Society of Anæsthetists.

Definitions

Before embarking on a discussion of the results certain definitions must be laid down. The possible circulatory complications were classified into "major" and "minor" as follows:

Major	Minor
Gangrene	Extracystoles
Emboli (including pulmonary)	Tachycardia
Phlebitis	Bradycardia
Circulatory failure	Moderate haemorrhage
Coronary thrombosis	Marked fall of blood-pressure without concomitant tachycardia
Angina pectoris	
Heart block	Hypertension
Auricular or ventricular fibrillation	
Traumatic "shock"	
Severe hæmorrhage	
Pericarditis	

The "Physical States" are defined as follows:

1. A patient with no systemic disorder.
2. A patient with moderate systemic disorder.
3. A patient with severe systemic disorder.
4. A patient with extreme systemic disorder which has already become an imminent threat to life.
5. A patient who is to undergo an emergency operation, but whose condition would otherwise qualify him for categories 1 or 2.
6. A patient who is to undergo an emergency operation, but whose condition would otherwise qualify him for categories 3 or 4.
7. The rare case in which the patient is moribund before operation.

An "emergency operation" is defined as: "a surgical procedure which, in the surgeon's opinion, should be performed as soon as possible."

Every case in which death occurred after the patient had exhibited a circulatory complication earlier in the postoperative period is recorded as a "fatal case."

Results

Table IA shows the results of anæsthesia for upper abdominal operations in patients with normal circulatory systems. The incidence of circulatory complications is higher after cyclopropane than after ether in the entire group, and this applies equally to both varieties of complications and to the "fatal cases." When the figures are broken down according

to the physical state of the patient the only facts which emerge are that complications become more frequent in patients of poorer general condition, and that they are relatively more common after cyclopropane than after ether. A glance at the data here presented reveals that the percentage of cases free from post-operative circulatory complications is less in each of physical states 1 to 6 for the patients anæsthetized with cyclopropane than for those anæsthetized with ether. As a crude test of the statistical significance of this result one might argue as follows: (1) if cyclopropane and ether are equally liable to produce post-operative complications, then the probability that these differences will all be in the same direction (all positive, or all negative) is $2/2^6 = 1/32$. (2) Since an outcome as extreme as that observed may be expected to occur rarely under the postulated conditions (only one time out of thirty-two in the long run), it seems reasonable to conjecture that patients anæsthetized with cyclopropane are more liable to post-operative circulatory complications than patients anæsthetized with ether. While this type of argument is extremely useful in many instances, it is not entirely satisfactory in the present situation on account of the fact that the several comparisons concerned are based upon widely differing numbers of observations. By ignoring this information the above test gives each of the six comparisons equal weight, which is unsatisfactory, since the percentages corresponding to the first three physical states are subject to considerably less error in sampling than those for physical states 4, 5, and 6.

To make better use of the information for physical states 1, 2, and 3 available in Table IA we note that the number of cases involved in these instances are sufficient for the application of the X' criterion, details of which are given in the appendix. The values of X' are + 1.17, + 1.53, and + 0.27 for the comparison of physical states, 1, 2, and 3 respectively; and are taken positive to indicate an *excess* of post-operative circulatory complications with cyclopropane. No one of these X' values is statistically significant (at the 0.5 level of significance $= \pm$ 1.96) viewed singly, nor are they statistically significant (at the same level) when viewed collectively, since their sum divided by $\sqrt{3}$ is only + 1.72, and the probability

of a larger numerical value than this is .085 on the supposition that cyclopropane and ether are equally liable to produce post-operative circulatory complications in patients of each of these physical states.*

While not statistically significant when viewed in isolation from the other results shown in Table IA, the small proportions in the first three physical states, of cases free from post-operative complications with cyclopropane as compared with ether suggest, when considered in connection with the relatively few cases involved in physical states 4, 5, and 6 showing the same tendency, that cyclopropane is more liable to produce post-operative circulatory complications than ether. This conjecture is further supported by the data in Table IB.

Table IB compares the results with the two agents in patients suffering from disease of the cardiovascular system. Although, as would seem probable, the absolute incidence of post-operative circulatory complications is higher than in the patients with normal circulatory systems, the relative incidence is higher after cyclopropane than after ether. Here the numbers of cases involved in physical states 2 and 3 are sufficient for the application of the X' criterion, the values obtained being + 0.14 and + 1.85 respectively. Both are positive but neither is statistically significant considered singly; nor are they statistically significant considered jointly, since $(\text{sum}/\sqrt{2}) = +1.39-$ only. If, however, we combine the three X' values based on the data of Table IA with the two X' values just obtained, we obtain $(\text{sum}/\sqrt{5}) = +2.26-$, a value definitely significant at the .05 level of significance (P = .024 - in fact). Thus the data of Tables IA and IB on the relative frequency of cases free from post-operative complications with cyclopropane and with ether *for physical states* 1, 2, *and* 3 suggest that *in upper abdominal operations* cyclopropane is more liable to be followed by post-operative circulatory complications than is ether; and this

* The supposition here is that for physical state 1, say, the probability of post-operative circulatory complications following cyclopropane is the same as the probability of postoperative circulatory complications following the use of ether. Similarly this supposition can be applied to physical states 2 and 3. There is no assumption here that the probabilities are the same from state to state.

inference is independent of the other data in these tables, which, incidentally, further support this contention.

In Table II the results of the lower abdominal operations are set forth in the same way. Among the patients with normal circulatory systems (Table IIA) the results with the two agents are almost identical. It is evident from the figures that post-operative circulatory complications are rarer after lower than after upper abdominal interventions. In Table IIA the data for physical states 1, 2, 3, and 5 permit a X' analysis, and yield +0.96, +0.61, −1.61, and −0.02 respectively. None of these are statistically significant at the .05 level considered singly and (sum $\sqrt{4}$) = −0.03 is clearly not significant. Here we have come upon negative values of X' for the first time, indicating that in these instances cyclopropane was observed to give rise to *fewer* post-operative circulatory complications than ether. In circumstances where cyclopropane and ether are *equally liable* to give rise to post-operative circulatory complications, positive and negative values of X' of the same magnitude are of equal probability. The closeness of the composite X' obtained here (−0.03) to its expected value (zero) strongly suggests that in lower abdominal operations on patients with normal circulatory systems the chances of post-operative circulatory complications with cyclopropane and ether are identical. The absence of any definite tendencies in the other figures of Table IIA supports this conclusion.

Among the patients with disease of the circulatory system (Table IIB), however, there was a higher incidence of circulatory complications after cyclopropane than after ether. Statistical analysis of this group shows that the patients of physical state 2 had more post-operative circulatory complications after cyclopropane than after ether, the excess being on the borderline of statistical significance at the 0.05 level, since $X' = +1.96$. For the data of physical state 3, the only other instance here with adequate numbers for a X' analysis, the value of $X' = +0.60$, which is clearly not statistically significant considered in isolation from other values. Combining the X''s for physical states 2 and 3 gives (sum/$\sqrt{2}$) = +1.82, which is not statistically significant at the .05 level ($P = 0.07$). While this value may be said to hint

at the possibility of greater numbers of circulatory complications following cyclopropane than ether, the evidence does not seem to be sufficiently strong to warrant this conclusion, since the other data in Table IIB seem to be about equally divided; and in view of the data of Table IIA. Considering the X' values of Tables IIA and IIB collectively, we obtain $(\text{sum}/\sqrt{6}) = 1.03$, which is clearly not statistically significant at the .05 level ($P = 0.30$); the implication being that the evidence does not seem to warrant a conclusion that in *lower abdominal operations* cyclopropane is more liable to be followed by post-operative circulatory complications than ether.

Summary of Analysis by Physical State

Viewing Tables IA, IB, IIA, and IIB collectively, we note that the sum of the ten separate X' values obtained above when divided by 11 yields $+2.25$, which is statistically significant at the .05 level of significance ($P = 0.024$ in fact). The implication is that *at least under some circumstances*, cyclopropane, when used as the anæsthetic agent in abdominal operations, is liable to be followed by more post-operative circulatory complications than is ether. In particular, the evidence (Tables IA and IB) suggests that this is the case among patients in physical states 1, 2, and 3 at the outset of an *upper abdominal operation*. The data in these two tables for other physical states are based on so few observations that no clear decision can be reached from them, but they do not refute the above conclusion. On the other hand, the data (Tables IIA and IIB) for patients undergoing *lower abdominal operations* suggests that under these circumstances post-operative circulatory complications are no more liable to follow when cyclopropane is used than when ether is used.

From time immemorial it has been accepted without question by anæsthetists that the lighter the anæsthesia the better for the patient.[10] This view is so widely held that it would be tedious to enumerate the many authors who have subscribed to it. Surgeons usually desire deep anæsthesia for abdominal operations because the more complete the inhibition of

reflexes and respiratory excursion, the more easily are these operations performed. We felt, therefore, that it would be of interest to investigate the relation, if any, between the depth of anæsthesia with these agents, and post-operative circulatory complications. Table III shows the result of this analysis in 692 cases of upper abdominal section, and Table IV the data for lower abdominal interventions. The "plane" referred to represents the deepest plane entered at any time during the anæsthesia, and it was estimated according to Guedel's definitions. In many of the cases anæsthetized with cyclopropane, "controlled respiration" [10] was resorted to, and in these an accurate estimation of the plane of anæsthesia is impossible. Among the ether cases, however, the estimation was fairly accurate.

A striking feature of Table III and IV is the steady increase in the total incidence of post-operative circulatory complications with increased depth of anæsthesia *except* in the cases of upper abdominal intervention in which cyclopropane was the anæsthetic agent (Table IIIA), where no trend is apparent. In the cases where a trend is noticeable (Table IIIB, Table IVA and IVB), it is also statistically significant (at the .05 level) and implies a real increase in the likelihood of post-operative circulatory complications with increase in depth of anæsthesia, confirming the general consensus mentioned above. The apparent exception—upper abdominal interventions with cyclopropane as the agent (Table IIIA)—is probably the result of resorting to "controlled respiration" in many of these cases as noted above. Additional weight is given to this explanation when it is noted that, when the differences between cyclopropane and ether at each plane are measured in terms of X', in order to make allowance for the numbers of patients involved, the greatest contrast between these agents occurs at plane 3 in connection with either upper or lower abdominal interventions. Thus, for the data of Table III, the X' values are $+1.26$, $+3.92$, and $+0.80$ for planes 2, 3, and 4 respectively, that for plane 3 being statistically significant (even at the .001 level) considered singly. Likewise, the data of Table IV yield X' values of $+0.69$, $+1.42$, and $+0.79$ for planes 2, 3, and 4 respectively, that for plane 3 coming closest to statistical

significance (at the .05 level) although none of these attain statistical significance (at this level) considered singly.

At this juncture it may be noted that the X' values just presented constitute additional, but not entirely independent, evidence in support of the conclusions reached earlier from the comparison of cyclopropane and ether on the basis of the classification by physical states. Thus, the above X' values for Table III considered collectively are statistically significant at the .001 level, since $(\text{sum}/\sqrt{3}) = 3.45$ and $P = 0.0006$, implying that in *upper abdominal operations* patients anæsthetized with cyclopropane are more liable to exhibit post-operative circulatory complications than patients anæsthetized with ether, at least in some circumstances. On the other hand, the X' values for Table IV considered collectively do not quite attain statistical significance at the .05 level, since $(\text{sum}/\sqrt{3}) = 1.68$ and $P = 0.09$, so that while the data of Table IV seem to point to the conclusion that in *lower abdominal operations* cyclopropane is more liable to be followed by post-operative complications than is ether, the data here presented do not warrant this conclusion. In the light of our findings from Table IIA and IIB the situation may be that in patients with diseased cardiovascular systems the above conclusion is true, while in normal patients cyclopropane and ether are identical in their effects. This point could have been investigated by dividing Table IV into two tables: one for patients with diseased cardiovascular systems, and one for patients with normal cardiovascular systems. This investigation was not carried out as it was not thought of until after the sorting of the cards had taken place.

Finally, there is a point not directly concerned with the agents cyclopropane and ether which may be examined with the aid of the data of Tables I to IV, namely, the relative incidence of post-operative circulatory complications following upper and following lower abdominal interventions. Comparing the corresponding portions of Tables I and II it is seen that generally, although not without exception, the incidence of post-operative circulatory complications was greater after the upper than after the lower abdominal operations. The situation is more clear cut in Tables III and IV, a comparison of the corresponding entries of which shows

quite definitely that post-operative circulatory complications are more liable to follow operations above the umbilicus than operations below the umbilicus, at least when the anæsthetic agent is cyclopropane or ether.

Summary

By means of the punched card system an investigation was conducted into the incidence of circulatory complications during the period in the hospital following an operation performed with cyclopropane or ether. The cyclopropane series consisted of 257 cases of upper abdominal, and 1268 cases of lower abdominal interventions. In the case of ether, the corresponding figures were 435 and 531. The relation between pre-operative cardiovascular disease, physical state, the agent in use, and post-operative circulatory complications has been considered both for upper and lower abdominal operations. These figures have been subjected to statistical analysis. The relationship between the plane of anæsthesia and post-operative circulatory complications has been investigated in a similar manner.

Conclusions

1. In a healthy patient subjected to anæsthesia for an upper abdominal operation, the tendency to circulatory complications is greater after cyclopropane than after ether, and is more marked among patients suffering from disease of the circulatory system.

2. The incidence of post-operative circulatory complications is higher after upper than after lower abdominal operations.

3. The data suggest that, after operations below the umbilicus, post-operative circulatory complications may be more liable to follow cyclopropane than ether anæsthesia, but the evidence is of insufficient strength to warrant this conclusion.

4. With ether, the deeper the plane of anæsthesia, the greater the incidence of circulatory complications in the post-operative period. In the case of cyclopropane this statement is true of lower abdominal operations. It is probably also

true of upper abdominal operations unless "controlled respiration" is in use.

The circulatory complications in the post-operative period, although of considerable importance, constitute only one of many factors which should be weighed when choosing the agent for use in any particular case. The facts enumerated above should be applied in practice with the judgment which only extensive clinical experience can give.

TABLE I.

UPPER ABDOMINAL OPERATIONS.

A. Patients with normal cardiovascular systems, classified by physical state.

1. Anæsthetized with cyclopropane. Total cases, 149.

Physical state	Total cases	No post-operative complications Number	%	Minor complications Number	%	Major complications Number	%	"Fatal cases"* Number	%
1	42	34	80.9	7	16.7	1	2.4	0	0
2	74	59	79.6	11	15.3	4	5.1	1	1.4
3	23	16	69.6	7	30.4	0	0	0	0
4	3	0	0	1	33.3	2	66.6	1	33.3
5	3	1	33.3	1	33.3	1	33.3	1	33.3
6	4	3	75.0	1	25.0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
Totals	149	113	75.8	28	18.8	8	5.4	3	2.0

2. Anæsthetized with ether. Total cases, 291.

Physical state	Total cases	No post-operative complications Number	%	Minor complications Number	%	Major complications Number	%	"Fatal cases" Number	%
1	107	96	89.6	8	7.5	3	2.8	0	0
2	147	130	88.4	17	11.6	0	0	0	0
3	30	23	76.7	4	13.3	3	10.0	2	6.7
4	2	1	50.0	0	0	1	50.0	0	0
5	4	4	100.0	0	0	0	0	0	0
6	1	1	100.0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
Totals	291	255	87.6	29	10.0	7	2.4	2	0.7

* See definition of p. 5.

TABLE I.

UPPER ABDOMINAL OPERATIONS

B. Patients with disease of the cardiovascular system before operation, classified by physical state.

1. Anæsthetized with cyclopropane. Total cases, 108.

Physical state	Total cases	No postoperative complications Number	%	Minor complications Number	%	Major complications Number	%	"Fatal cases" Number	%
2	52	40	76.9	6	11.5	6	11.5	1	1.9
3	47	30	63.8	13	27.6	4	8.5	2	4.2
4	3	2	66.6	1	33.3	0	0	0	0
5	1	1	100.0	0	0	0	0	0	0
6	5	1	20.0	2	40.0	2	40.0	2	40.0
7	0	0	0	0	0	0	0	0	0
Totals	108	74	68.5	22	20.4	12	11.1	5	4.6

2. Anæsthetized with ether. Total cases 144.

Physical state	Total cases	No post-operative complications Number	%	Minor complications Number	%	Major complications Number	%	"Fatal cases" Number	%
2*	83	66	79.5	11	13.2	6	7.2	2	2.4
3	55	45	81.8	6	10.8	4	7.3	2	3.6
4	3	2	66.6	0	0	1	33.3	1	33.3
5	0	0	0	0	0	0	0	0	0
6	3	2	66.6	1	33.3	0	0	0	0
7	0	0	0	0	0	0	0	0	0
Totals	144	115	79.9	18	12.5	11	7.6	5	3.5

*By definition, no patient with disease of the cardiovascular system can be classified in physical state 1.

TABLE II.

LOWER ABDOMINAL OPERATIONS

A. Patients with normal cardiovascular systems, classified by physical state.

1. Anæsthetized with cyclopropane. Total cases, 1020.

Physical state	Total cases	No post-operative complications Number	%	Minor complications Number	%	Major complications Number	%	"Fatal cases" Number	%
1	469	423	90.2	42	8.95	4	0.85	0	0
2	282	238	84.3	33	11.7	11	3.90	3	1.06
3	60	54	90.0	1	1.7	5	8.3	3	5.0
4	1	1	100.0	0	0	0	0	0	0
5	201	190	94.5	9	4.5	2	1.0	0	0
6	6	1	16.7	3	50.0	2	33.3	2	33.3
7	1	1	100.0	0	0	0	0	0	0
Totals	1020	908	89.0	88	8.6	24	2.3	8	0.78

TABLE II (*Continued*)

2. Anæsthetized with ether. Total cases, 416.

Physical state	Total cases	No post-operative complications Number	%	Minor complications Number	%	Major complications Number	%	"Fatal cases" Number	%
1	209	194	92.8	14	6.7	1	0.5	1	0.5
2	133	116	87.2	15	11.3	2	1.5	1	0.7
3	22	16	72.7	2	9.1	4	18.2	3	13.6
4	3	3	100.0	0	0	0	0	0	0
5	43	40	93.0	3	7.0	0	0	0	0
6	6	5	83.3	0	0	1	16.6	1	16.6
7	0	0	0	0	0	0	0	0	0
Totals	416	374	89.9	34	8.2	8	1.9	6	1.4

TABLE II.

LOWER ABDOMINAL OPERATIONS

B. Patients with disease of the cardiovascular system before operation, classified by physical state.

1. Anæsthetized with cyclopropane. Total cases, 248.

Physical state	Total cases	No post-operative complications Number	%	Minor complications Number	%	Major complications Number	%	"Fatal cases" Number	%
2*	148	118	79.7	23	15.5	7	4.7	3	2.0
3	81	64	79.0	9	11.1	8	9.9	2	2.5
4	3	2	66.6	1	33.3	0	0	0	0
5	8	8	100.0	0	0	0	0	0	0
6	8	6	75.0	0	0	2	25.0	0	0
7	0	0	0	0	0	0	0	0	0
Totals	248	198	79.8	33	13.3	17	6.9	5	2.4

2. Anæsthetized with ether. Total cases, 115.

Physical state	Total cases	No post-operative complications Number	%	Minor complications Number	%	Major complications Number	%	"Fatal cases" Number	%
2*	70	64	91.4	5	7.1	1	1.4	0	0
3	41	35	85.3	5	12.2	1	2.4	1	2.4
4	2	1	50.0	0	0	1	50.0	1	50.0
5	2	2	100.0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
Totals	115	102	88.7	10	8.7	3	2.6	2	1.7

*By definition, no patient with disease of the cardiovascular system can be classified in physical state 1.

TABLE III.

UPPER ABDOMINAL OPERATIONS

A. Patients anæsthetized with cyclopropane. Total cases, 257.

Plane	Total cases	No post-operative complications Number	%	Minor complications Number	%	Major complications Number	%	"Fatal cases" Number	%
1	4	3	75.0	1	25.0	0	0	0	0
2	53	40	75.4	11	20.7	2	3.8	2	3.8
3	94	64	68.0	23	24.5	7	7.4	3	3.2
4	106	80	75.5	15	14.1	11	10.4	3	2.8
Totals	257	187	72.8	50	19.4	20	7.8	8	3.1

B. Patients anæsthetized with ether. Total cases, 435.

Plane	Total cases	No post-operative complications Number	%	Minor complications Number	%	Major complications Number	%	"Fatal cases" Number	%
1	6	6	100.0	0	0	0	0	0	0
2	29	26	89.7	2	6.9	1	3.4	0	0
3	242	211	87.2	19	7.8	12	5.0	5	2.1
4	158	127	80.4	26	16.4	5	3.2	2	1.3
Totals	435	370	85.0	47	10.8	18	4.1	7	1.6

TABLE IV.

LOWER ABDOMINAL OPERATIONS

A. Patients anæsthetized with cyclopropane. Total cases, 1268.

Plane	Total cases	No post-operative complications Number	%	Minor complications Number	%	Major complications Number	%	"Fatal cases" Number	%
Analg.	1	1	100.0	0	0	0	0	0	0
1	26	26	100.0	0	0	0	0	0	0
2	626	557	89.0	53	8.5	16	2.5	6	0.96
3	384	327	85.1	42	10.9	15	3.9	5	1.3
4	231	195	84.4	27	11.7	9	3.9	2	0.86
Totals	1268	1106	87.2	122	9.6	20	3.1	13	1.02

B. Patients anæsthetized with ether. Total cases, 531.

Plane	Total cases	No post-operative complications Number	%	Minor complications Number	%	Major complications Number	%	"Fatal cases" Number	%
Analg.	0	0	0	0	0	0	0	0	0
1	9	9	100.0	0	0	0	0	0	0
2	119	109	91.6	6	5.0	4	3.4	4	3.4
3	262	234	89.3	23	8.8	5	1.9	3	1.1
4	141	124	87.9	15	10.6	2	1.4	1	0.7
Totals	531	476	89.6	44	8.3	11	2.1	8	1.5

Appendix

The statistical analyses of this paper are based upon a modification of the chi-square method of analysis of four-fold tables, a discussion of which for medical readers is available in Chapter II of *The Treatment of Clinical and Laboratory Data*, by Donald Mainland, M.B., Ch.B., D.Sc. (Oliver and Boyd, Edinburgh, 1938). Denoting the four-fold table by

a	b	$a+b$
c	d	$c+d$
$a+c$	$b+d$	$a+b+c+d$

then

$$X^2 = \frac{N(ad-bc)^2}{(a+c)\,(b+d)\,(c+d)\,(a+b)}$$

Where $N = a+b+c+d$. Since, when the marginal frequencies are given, the entire table is determined by specifying a single one of the numbers in the interior of the table, this X^2 is said to have a single degree of freedom.

F. Yates[11] has shown that the accuracy of the X^2 method is considerably increased by a simple "correction for continuity" which is discussed on page 92 of Mainland's book. Denoting this modified X^2 by X'^2, it is not difficult to show that

$$X'^2 = \frac{N(\ |ad-bc|\ -\tfrac{1}{2}N)^2}{(a+c)\,(b+d)\,(c+d)\,(a+b)}$$

where $|ad-bc|$ means the value of $(ad-bc)$ taken *positive*.

For the purpose of the present study it has been advantageous to employ X' itself instead of its square, assigning to it a plus or minus sign according as $(ad-bc)$ is plus or minus. In setting up our four-fold tables, we employed an arrangement which resulted in a + value of X' whenever cyclopropane showed a greater number of post-operative complications than ether, and a − value of X' when the reverse was true.

Illustrative Calculation

The data for *lower abdominal operations* on patients with diseased cardiovascular systems in physical state 2 (Table IIB are:

POST-OPERATIVE CIRCULATORY COMPLICATIONS

	Cases with some	Cases with none	Total
Cyclopropane	30	118	148
Ether	6	64	70
Total ...	36	182	218

$$X' = +(\ |(30)(64) - (118)(6)|\ - \tfrac{1}{2}(218)) / \sqrt{\frac{(36)(182)(70)(148)}{218}}$$

$$= +1103/558.0 = +1.98-$$

The Problem. Our purpose in calculating X' in any case will be to answer a question which, in terms of the above illustration, may be expressed as follows: Let p_c denote the *true* probability of complications following the use of cyclopropane, and let p_E denote the *true* probability of complications following the use of ether *for persons with diseased cardiovascular systems and in physical state 2 at the outset of a lower abdominal operation.* Our problem is to decide on the basis of the data at hand whether $p_c = p_E$ or not.

Solution. A solution to the above problem can be obtained easily in view of the fact that X' as defined above will be distributed approximately normally about a mean of zero with unit standard deviation *in random samples* from a population in which $p_c = p_E$, provided the marginal frequencies are sufficiently large. (For explicit conditions see the paper by Yates referred to above.) Furthermore, under these same general conditions, X' will be normally distributed about a positive mean when p_c is greater than p_E and about a negative mean when p_c is less than p_E.

With reference to the above illustrative data, we note that X' exceeds the .05 significance level (± 1.96), so that *if the method of obtaining these data was equivalent to random sampling from the "population" specified by the underlined words in the statement of the problem*, then we may assert that p_c is not equal to p_E, and the probability of this assertion being false is less than .05 (In view of the borderline character of this result if one is using the .05 level of significance, one would probably wish to reserve a verdict

that p_c was greater than p_E until further data were examined.)

The underlined premise is important. In agricultural sampling the validity of this assumption is insured by consciously introducing a random operation (e.g. drawing cards from a hat, tossing dice, etc.) in the sampling technique. Since non-randomness of sampling from a "population" wherein $p_c = p_E$ could also result in an abnormally large X' such as the above, it is clear that information regarding the randomness of sampling is essential. In medical work of the type under consideration here, random sampling of patients is not feasible. Probably the best that can be asked is that the data employed include all persons whose general health is as described and whose difficulties were such as to require operative treatment of the type under consideration.

Combination of Several X' Values

When several, say k, X' values are at hand and it is desired to test the hypothesis that $p_c = p_E$ in all k cases, a composite test is obtained by calculating (sum X' values $/ \sqrt{k}$) and comparing this with the significance levels of a normally distributed variable with mean of zero and standard deviation of unity, tables of which are available.[12, 13] For ready reference we note the following levels:

P	.50	.25	.10	.05	.01	.001
X'	0.674	1.15	1.64	1.96	2.33	3.29

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A METHOD OF KEEPING ANÆSTHETIC RECORDS AND ASSESSING RESULTS

BY

MICHAEL NOSWORTHY, M.D., D.A.

THE keeping of anæsthetic statistics is not new[1] and in recent years a most comprehensive punch-card system has been standardized by the Committee of Records and Statistics of the American Association of Anesthetists.[2] The present aim was to combine on the same card the usual anæsthetic chart for collecting and recording all the relevant data as well as a method for assessing results statistically without having to use either a code book or a sorting machine. The anæsthetic record to be described is printed on a card 8 inches by 5 inches in size.

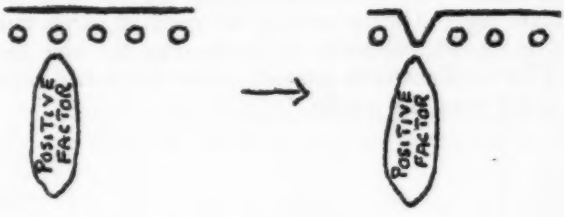
THE PRINCIPLE OF THE METHOD

Around the four sides of the card holes are punched. What each group of holes and each individual hole represents is shown by headings and subdivisions printed against them on the front of the card (Fig. 1). Whilst the operation is in progress attention is given to the back of the card (Fig. 2). Details of the operation performed and the anæsthetic administration are filled in, positive factors are encircled, and observations are recorded on the graphic chart.

This chart is divided by vertical lines into five-minute intervals extending over a period of three and a half hours—the actual hours of operation being written along the top of the chart. The agents used are indicated by a solid line opposite the name or chemical symbol which appears on the extreme left. The amount of oxygen added per minute—

when the CO_2 absorption technique is being used—is indicated by a line opposite the appropriate figure in the margin (e.g. 200 c.c./MIN.). The percentage of oxygen in the anæsthetic mixture—when open or semi-open gas techniques are being used—is indicated by a similar line opposite the appropriate figure from which the final "0" has been deleted (e.g. 20ø = 20%). The plane of anæsthesia is indicated by a line opposite the appropriate number 1, 2, 3, or 4. The figures from 0 to 200 at the side of the chart are used to represent the systolic and diastolic blood-pressures in millimetres of mercury, the pulse-rate in beats per minute, and the respiratory-rate per minute by placing characteristic marks at the proper levels. The code at the side of the chart shows that check marks indicate the systolic and diastolic blood-pressures, small dots the pulse-rate, and small circles the respiratory-rate. The beginning and end of the anæsthetic administration is recorded by a properly placed X, and a dot enclosed in a circle denotes the beginning and end of the operation. Interesting happenings are explained by brief numbered remarks in the column provided and their timing denoted by corresponding numerals accurately placed at the foot of the chart.[3]

From the theatre the records go to the anæsthetic department where each is issued with a serial number which, with the patient's name and the actual operation performed, is entered in a card index. The data collected at operation, like other positive factors noted on visiting the patient during his stay in hospital, are subsequently marked with a circle in their appropriate subdivisions round the sides on the front of the card. When the patient has left hospital the holes opposite the encircled positive factors are converted into slots by cutting out a "V" from the edge of the card opposite



each with a pair of special nippers or scissors. During sorting, later on, the slots permit the separation of the positive factors from the negative factors the holes opposite which will still be intact.

The preliminary ringing of all positive factors serves as a safeguard against the chance of a mistake in slotting. Finally, as proof that the record has been completed and is now ready for filing, the corner marked with the diagonal line is snipped off.

Sorting of a pack of completed records is accomplished by running a knitting needle through the hole representing the factor under consideration, by spreading the pack over its length in order to prevent any cards from clinging together, and then by raising the needle. For example, if it is desired to find mortality figures the needle is passed through the hole marked "DIED," and the cards of all patients who died in hospital—since they will have had this hole slotted—will fall from the pack; whereas the rest of the cards, representing all patients discharged from hospital, will be supported on the needle—since they will have the "DIED" hole left intact. By repeating this manœuvre it is possible to find quickly all statistical data required—e.g. the number of a given type of operation performed under a particular anæsthetic technique and the postoperative morbidity and mortality, etc.

Cards must obviously all be "facing front" and also "right side up" before sorting is commenced. All cards must therefore be filed away with the "cut-off" corner in the same relative position. If the cards in a pack happen to become jumbled up, however, they may be quickly re-arranged facing front and the right side up by inserting the needle first through one corner hole, lifting away the projecting cards and repeating this operation through two more corner holes. This is the sole purpose for which the corner holes are used. During sorting the pack of cards must be stood on the edge opposite to that bearing the hole through which the needle is to be passed, so that the slotted cards are free to fall from the needle.

ANÆSTHETIC RECORD

No. ——— Ward ———

Hosp. ——— ———

Name ——— ——— Age 48

B.P. 90/60 T.P.R. 97°/86/20 Wt. 8.7.0

Hb. 80% R.B.C. 4,690,000 W.B.C. 3,000

Diagnosis & Operation proposed — Date ———

Gastro-colic fistula — for closure

5 weeks Abd. pain & vomiting.
3 weeks Diarrhoea & foul flatulence
Debilitated — has lost over 3 stone in wt.

Details of Preoperative Complications and Previous Anæsthetic History

Dehydrated in spite of I.V. Saline.

Breath Sounds distant.

Gastro-enterostomy 10 years ago
No details of anaesthetic.

Details of Postoperative Complications

Condition Satisfactory.
I.V. Saline for 24 hours
Oxygen therapy by B.L.B. mask
for 48 hours — No abdominal
distension developed

Some cough & sputum with a
few scattered rhonchi audible
in the lungs for the first two
days after operation.

Result

Discharged fit 4 weeks after
operation, having gained 16 lbs in wt.

THE COPELAND-CHATTERSON PARAMOUNT CARD
PAT. NOS. 229069, 297992, C.C. 87797 K

Site of Operation (K): Major Operation; Minor Operation; Extremities; Perineal; G.U.; Inguinal; Lower Laparotomy; Upper Laparotomy; Body-Wall; Intrathoracic; Other Head & Neck; Testicle; Mouth, Nose & Throat; Brain & Spinal Cord

Sex (A): M; F

Age (B): -10; -20; -40; -60; 61 & over

Time in Hrs. (L): -½; -1; -2; 2+

Pre-Medication (M): Opiate; Oral; Rectal

Anæsthetic Agents (N): Regional; Spinal; I.V.; N_2O; C_3H_6; Ether; Ethyl-Chloride; $CHCl_3$; Other; Agents Used: One; Two; Three

Physical State (C): 1. Good; 2. Fair; 3. Poor; 4. Serious; Emergency

Preoperative Complications (D): Incomplete Data; Resp. Major; Resp. Minor; C.V.S.; C.N.S.; G.U.; Gastro-Intestinal; Metabolic

Special Study (E): Anæs. Record of Special Interest

Techniques (F): Open or Insufflation; Absorption; Semi-Open or Closed; Orotracheal; Nasotracheal

During Anæsthesia (G): 1. Emergency; 2. I.V. Therapy; 3. C.V.S. Disturbances; 4. Respiratory Disturbances; 5. Administration Satisfactory

Reflexes in Th. without Comps. (H)

Max. Depth of Maintenance (I): 0; 1; 2; 3; 4

Postoperative Complications (O): Technical; Resp. Major; Resp. Minor; .. 1–4 Days; .. Later; C.V.S. First 24 Hrs.; C.V.S. Later; C.N.S.; G.U.; Other; None of Above; Vomit O

(Q) Inhalation Therapy Administered

(P) Tracheo-Bronchial Suction Applied: .. –12 Hrs.; .. –24 Hrs.; .. 24+ Hrs.

Time of Death (S): On Table; 1–3 Days; 4–14 Days; Later

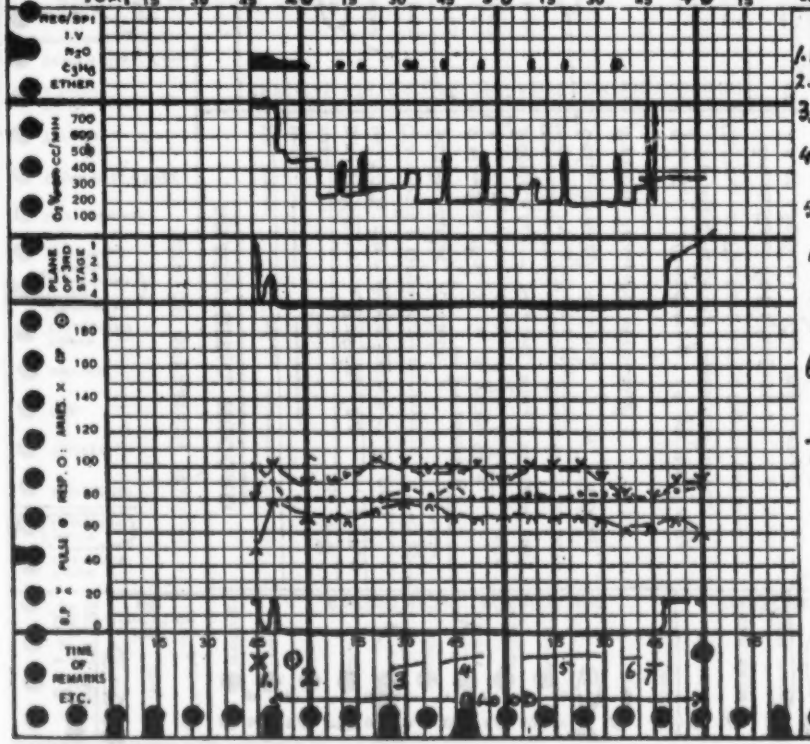
(R) Died

(T) Autopsy Performed

Cause of Death (U): Anæsthesia; C.V.S.; Respiratory; Infection; Existing Disease; Other Causes

DATE —— OPERATION PERFORMED CLOSURE OF GASTRO-JEJUNO-COLIC FISTULA

SURGEON —— ANAESTHETIST ——



REMARKS.

1. INTUBATION
2. PERITONEUM
3. CLOSING COLON
4. CLOSING STOMACH
5. JEJUNUM CONSTRICTED AT ANASTOMOSIS. DIVIDED. END TO END ANASTOMOSIS
6. CLOSING HOLE IN TRANS!-MESO-COLIC
7. CLOSING PERITONEUM.

ENCIRCLE POSITIVE FACTORS ON BOTH SIDES OF CARD.

PREMEDICATION, DRUGS & DOSES

OPOIDINE gr ⅓ } 1 hr b.o.
ATROPINE gr 1/100 }

SATISFACTORY. TOO DEPRESSED. APPREHENSIVE

ANAESTHETIC AGENTS

C_3H_6

TECHNIQUES & TYPE OF APPARATUS

CLOSED → ABS. (To & Fro)

OROPHARYNGOTRACHEAL R L BLIND

CUFF PACK UNDER MASK

TECHNICAL DIFFICULTY

1. MASSIVE HÆMORRHAGE GRAVE OXYGEN WANT
   CARDIAC ARREST CONVULSION EXPLOSION
2. I.V. THERAPY BLOOD OUT
3. ARRHYTHMIA BRADY/TACHYCARDIA
   MARKED B.P. FALL/RISE SHOCK
4. RESP. DEPRESSION MOD. RESP. OBSTRUCT.
   SEV. LARYNG. OBSTRUCT. EXCESS MUCUS
   RETCH VOMIT MUCH COUGH
5. INDUCTION SATISFACTORY. YES NO
   MAINTENANCE SATISFACTORY. YES NO

RECOVERED REFLEXES IN THEATRE YES NO

RETCH VOMIT EXCIT. SEV. OBSTRUCT.

THE ANÆSTHETIC RECORD IN USE

It will be apparent that the holes round the sides of the card are arranged in groups with headings marked "A–U" (Fig. 1). At the anæsthetist's preoperative visit to the patient positive factors in groups "A–D" are encircled, i.e. the patient's sex, age, physical state, and any preoperative complications presented. The reason for so grading the physical state and details of why a preoperative complication has been encircled must be entered in the appropriate place in the centre of the card together with the other relevant data.

Positive factors in groups "E–N" are encircled after the operation has been performed—the requisite data being transferred from the back of the card.

Positive factors in "O," and "P" and/or "Q" if positive, are encircled during postoperative visits to the patient and details of any such, together with other relevant comments, must be entered in the centre of the card. Attention is, in like manner, given to encircling and recording details of positive factors in "S," "T," and "U" on cards in which "R" is positive (i.e. the patient having died in hospital).

Reference to the Anæsthetic Record here reproduced will illustrate how the data are collected.

The patient was a male (A). His age was 48 and therefore fell in the "–60" group (B). He was suffering from a gastro-colic fistula and on account of his debilitated condition he was graded Physical State 3 (C). In spite of intravenous saline he had definite evidence of dehydration which was his C.V.S., and only significant, Preoperative Complication (D). No particular Anæsthetic Study was being undertaken, nor did the Anæsthesia Record show any happening of Special Interest (E).

The inhalation technique used was Absorption by the Oro-tracheal route (F); details on the back of the card show that Waters's "to and fro" absorption method was employed after a closed induction, and that a cuff was used on the endo-tracheal tube.

Intravenous Therapy—2 pints of blood noted on the back of the card—was administered during operation, and the Anæsthetic Administration was Satisfactory (G). The patient

recovered his Reflexes in the operating Theatre Without Complications (H).

The Maximum Depth of Maintenance was recorded as the 4th plane—reference to the back of the card showing that "controlled respiration" was used almost throughout (J). An Upper Laparotomy was the site of operation, the procedure being a Major Operation (K)—recorded on the back of the card as "Closure of a Gastro-jejuno-colic fistula." The operation took "over 2 hours" to complete (L).

An Opiate (Opoidine gr. 1/3 and Atropine gr. 1/100, one hour before anæsthesia, having a "satisfactory" effect noted on the back of the card) was the only form of Premedication (M). One Anæsthetic Agent only, to wit Cyclopropane, was used (N).

After operation the administration of intravenous saline was resumed for twenty-four hours. A high oxygen atmosphere (Q) was delivered to the patient by means of a B.L.B. mask for forty-eight hours with intent to prevent the postoperative development of abdominal distension—none occurred.

The patient developed a Minor Respiratory Complication, the time of onset of which occurred within four days of operation (O)—some cough and sputum with a few scattered rhonchi audible in the lungs for the first two postoperative days. Otherwise the patient's convalescence was uneventful, and he was discharged fit four weeks after operation, having gained 16 lb. in weight.

Some may say that the anæsthetist cannot pay attention to his patient and keep a chart at the same time. In point of fact the observations made in keeping the record necessitate a very close watch being kept on the patient. As the operation proceeds these observations take shape as a graph, and the anæsthetist soon realizes that certain phenomena produce typical reactions on the part of the patient; for example, an intrathoracic tumour was diagnosed by the anæsthetist from his chart as a goitre some twenty minutes before the surgeon arrived at the same conclusion. Again, just as a temperature chart is much more illuminating than are a series of figures in a report book, so a chart showing the trend of blood-pressure or other changes helps towards a quicker and more

accurate appreciation of the patient's condition and so an earlier opportunity to correct any undesirable state.[4] Besides focusing the anæsthetist's attention upon the patient and how he is affected by what is done to him, as Waters stresses, records also serve as a basis for later leisurely discussion on procedures and results; that is, they are the basis for all teaching and all improvements in practice. Without well-kept records we are deprived of a basis for discussion, comparison and conclusion, and are left dependent upon memory and personal opinion as a foundation for instruction and for progress.[5]

How to keep such a record as that described is not difficult to understand, but in order that there may be uniformity of usage amongst anæsthetists working in different places suggestions for the standardization of record-keeping are set out below.

THE STANDARDIZATION OF RECORD-KEEPING

Group "A" is self-explanatory. The first hole in group "B" covers patients of 10 years old or less, the second hole those whose ages lie between 11–20 inclusive, and so on.

Physical State

The physical state of the patient (group "C") must be judged entirely on his physical condition as a result of physical, X-ray, and laboratory examinations. This practice will result in much greater accuracy and uniformity in the grading of patients than would be the case were an attempt made to take into consideration as well other factors such as the severity of the proposed operation, the experience of the surgeon or the anæsthetist, the attention to the postoperative care, etc. For instance, were these variable factors allowed to influence the grading of the patient the same patient might be considered a fair risk for a minor operation but a poor risk for a major surgical intervention. Again, the anæsthetist might consider the same patient about to undergo, say, a partial gastrectomy as representing a different risk depending upon whether an expert or inexperienced team was to

take part in the operation, and depending also upon where this operation was to be performed.

By grading only the physical state of the patient something definite is assessed from the statistical point of view.[6] The various grades of physical state may be defined as follows:

Grade 1 denotes that the patient shows no organic disease or that the pathological process, to be treated surgically, is localized and is not causing any systematic disturbance.

Grade 2 denotes a moderate but definite systemic disturbance caused either by the condition to be treated surgically or by a preoperative complication elsewhere.

Grade 3 denotes severe systemic disturbance from any cause or causes.

Grade 4 denotes extreme systemic disorders.

Emergency. When operation has to be performed without delay and the ordinary routine investigations have to be dispensed with, the "Emergency" hole should be encircled in addition to the estimated grade of physical state. When sorting is done all the emergency cases can be separated by needling the emergency hole first. Otherwise, cases can first be separated into their various grades, after which a further sort will give the number of emergency cases in each grade.

No patient with a Preoperative Complication can, by definition, be graded as Physical State 1. A patient with no definite preoperative complication may, however, be graded as Physical State 2 or 3 in view of poor muscle tone, senility, debility, wasting, anæmia of moderate degree, cachexia, infection, etc.

Preoperative Complications

Nine holes are devoted to group "D" and more than one may be encircled on any card. Details of all preoperative complications—significant or otherwise—must be entered in the space allotted in the centre of the card. It is strongly suggested, however, that the ringing of individual holes be restricted to the pathological conditions set out below, since these factors, when positive, are the only ones, in the author's opinion, of real significance.

Incomplete Data. The encirclement of this factor infers that the patient—who is not about to undergo an emergency operation—has, in the anæsthetist's opinion, been investigated insufficiently to exclude the presence, or inadequately to determine the degree, of factors which may possibly influence the outcome. For example, failure to estimate the actual hæmoglobin percentage in a possibly anæmic patient; failure to X-ray the chest of a patient with doubtful pulmonary signs or symptoms; failure to exclude active antral or other upper respiratory infection in patients with coincidental symptoms of such, etc.

Respiratory Major. A Marked Reduction in Vital Capacity or Major degrees of Respiratory Obstruction, Depression, or Infection from any cause indicate the encircling of this factor. Pulmonary œdema, tuberculosis, all types of pneumonia, active bronchial asthma or bronchitis, moderate and severe degrees of emphysema, lung abscess, bronchiectasis, partial or massive atelectasis, intrathoracic tumour, pleural effusion or pneumothorax, foreign matter in the tracheo-bronchial tree, marked laryngeal obstruction or tracheal compression are among the chief causes.

Respiratory Minor. A Moderate Reduction in Vital Capacity or Minor degrees of Respiratory Obstruction, Depression, or Infection from any cause indicate the encircling of this factor. Cough, oral sepsis, upper respiratory infections, laryngitis, tracheitis, pleurisy, bronchial asthma in the quiescent period, and mild degrees of bronchitis and emphysema are among the chief causes.

C.V.S. This factor should be encircled only if the patient presents one or more of the following abnormalities: (1) Congenital heart disease associated with cyanosis. (2) A large heart from any cause. (3) Heart disease with signs of failure, or a history of recent failure. (4) Partial or complete heart block or an abnormal rhythm (other than simple extrasystoles). (5) Significant venous thrombosis, or embolus. (6) Myocardial damage from an attack within the previous two years of coronary disease. (7) A hæmoglobin value below 60 per cent or a severe recent hæmorrhage. (8) Signs of peripheral circulatory failure or a history of recent recovery therefrom. (9) Definite evidence of dehydration.

Although their presence should be recorded in the centre of the card valvular disease or hyperpiesia, without signs of failure or cardiac enlargement, are regarded as of little significance.

C.N.S. This factor should be encircled only if the patient is irrational, unco-operative, or comatose; or when there is present an increased intracranial pressure, or nerve palsies likely to predispose the patient to respiratory or other sequelae.

G.U. The presence of low renal function, suppression, acute retention, or severe infections of the tract indicate the encirclement of this factor.

Gastro-intestinal. This factor should be encircled only if the patient has a perforated or acutely infected viscus (hollow or solid), gross abdominal distension, or a major degree of intestinal obstruction.

Metabolic. The presence of jaundice or poor liver function; definite alkalosis or acidosis; or marked endocrine disfunction, such as thyrotoxicosis, *uncontrolled* diabetes, gross obesity, etc., indicates the encirclement of this factor.

Heading "E"

The "Special Study" hole is encircled when a special investigation is being made into any particular problem, e.g. a particular type of operation, a new anæsthetic agent or method, the study, say, of the occurrence of arrhythmias during anæsthesia, etc.

The "Special Interest" hole is encircled when the anæsthetic chart shows the presence of abnormal physical signs or unusual respiratory, C.V.S., or other changes to which reference may be required at some subsequent date—e.g. for teaching purposes.

Techniques

Three holes are provided to show different inhalation techniques in group "F." If the technique used for induction differs from that used for maintenance both positive factors *can* be encircled. Those with little secretarial assistance, how-

ever, are advised to encircle only the technique used for maintenance—or that for induction if this period was the longer. Full details of the techniques used are written on the back of the card together with the type of apparatus employed, e.g. to and fro, or circle absorber, etc.

The fact that endotracheal anæsthesia was used is shown by encircling in addition the hole appropriate to the route employed—either Orotracheal or Nasotracheal. The encirclement of positive factors on the front of the card provides further details about the intubation to which reference may be desirable during the patient's convalescence or at some later date. There is recorded whether the intubation was accomplished "Blind" without direct vision laryngoscopy; whether the right or left nostril was used; whether a cuffed tube or a throat pack was employed, or whether the tube was used merely as a laryngeal airway under the mask; and finally whether intubation was technically difficult and a note if any trauma was inflicted.

During Anæsthesia

The five numbered subdivisions in Section "G" refer to the similarly numbered groups printed on the right side of the back of the card (Fig. 2) positive factors in which would be encircled during the administration.

1. *Emergency* is encircled if either a Massive Hæmorrhage, Grave Oxygen Want, Cardiac Arrest, a Convulsion, or an Explosion occurred during anæsthesia. On sorting the cards it will not be possible to discover the incidence of *each individual type* of emergency by needling. The total number of cards, however, will be small—although the group is interesting and important—and it will take little time, if complete details are required, to refer to the back of each card and so find the actual emergency encircled with full details of its occurrence and treatment.

2. *I.V. Therapy* refers to the same heading on the back of the card against which, if positive, must be recorded the type and quantity of fluid or drug administered. The time of its administration should be marked, like that of other interesting happenings, at the foot of the chart.

3. *C.V.S. Disturbances* in like manner is encircled if Arrhythmia, Bradycardia or Tachycardia, a Marked Fall or Rise in Blood-Pressure, or Shock was observed and ringed during the administration.

4. *Respiratory Disturbances.* It will be observed that "Retch" and "Vomit" are included in this group on the back of the card. The possible aspiration of foreign matter and hence a predisposition to postoperative respiratory complications warrants their inclusion under this heading.

Any other factor which disturbs the smooth course of anæsthesia—although not specifically set out here—should be noted in the relevant group, e.g. blood or other foreign body in the respiratory tract would be noted in the Respiratory Disturbances Group, etc.

5. *Administration Satisfactory* is encircled provided both induction and maintenance have satisfied both surgeon and anæsthetist. Space is left on the back of the card for the anæsthetist to state why either was not satisfactory. For example, below Induction the comment "Struggling" or "Respiratory Obstruction" might perhaps be called for; below Maintenance perhaps the comment "Muscular Rigidity" or "Spinal Block Too Low (or Failed)."

Headings "H" and "J"

Heading "H" should only be encircled if the back of the card records that the patient recovered his reflexes in the operating theatre *without* retching, vomiting, excitement, severe respiratory obstruction, or any other unspecified complication.

Heading "J" has five holes. "O" represents Analgesia only, while holes 1–4 denote which was the deepest of Guedel's planes of the 3rd stage[7] used for maintenance—as recorded on the chart on the back of the card. If a patient is pushed momentarily at the close of a quick induction down, say, into the 4th plane for intubation and subsequently maintained in, say, the 2nd plane, throughout the operation, hole "2" should be encircled. In all other circumstances the deepest plane which the patient ever entered is to be encircled.

Site of Operation

Section "K" is a double one since besides encircling the site of operation the anæsthetist must also encircle whether the operation was a "Major" or a "Minor" intervention.

The proposed operation and date thereof is written in the space allotted in the centre of the front of the card beforehand, and the operation actually performed together with the date and the surgeon's and anæsthetist's names are recorded on the back of the card. Changes of the patient's posture are to be noted at the foot of the chart.

The operation sites themselves are almost self-explanatory. "Brain and Spinal Cord" includes operations on the spine. "Mouth, Nose, and Throat" are grouped together as procedures during which—unless care is exercised—blood may be aspirated into the air passages. "Other Head and Neck" includes all operations on these regions not included in the three foregoing sites; operations on the eye and ear will therefore come into this fourth site.

"Body Wall" includes operations on the chest wall such as amputation of breast or thoracoplasty as well as all operations on the abdominal wall which do not involve the peritoneum, the genito-urinary tract, or the inguinal region.

An operation, such as an abdomino-perineal excision of rectum, involving two operation sites would be encircled as a "Lower Laparotomy" and also as a "Perineal"—and of course a "Major"—operation.

A minor operation, strictly defined, is one producing no constitutional disturbance and carrying a negligible mortality and morbidity. For statistical purposes, however, an operation is to be considered "major" or "minor" in relation to the operative site involved. Thus, for example, the removal of a non-toxic, non-obstructive adenoma of the thyroid gland will be considered a "minor" procedure, whereas the removal of a toxic or obstructive gland would constitute a "major" operation. Any laparotomy is to be considered a "major" intervention and likewise any surgical interference involving the lung or mediastinum.

Section "L" refers to the actual operating time and not to the duration of the anæsthetic administration. The com-

mencement and the termination of both the anæsthetic administration and the operation are to be marked at the foot of the chart on the back of the card, so that the duration of induction can be readily ascertained.

The Anæsthetic

Three holes are devoted to Premedication (M). "Opiate" includes morphine or any opium-derivative. "Oral" includes all sedative drugs administered by mouth. "Rectal" covers all sedative or basal hypnotic drugs administered by that route. More than one factor may have to be encircled. The drugs and doses, the time they were given and the effect they produced are recorded on the back of the card in the space allotted.

Section "N" is a composite group. "One," "Two," or "Three" are encircled according to the number of anæsthetic agents used. It will be observed that opposite each of the anæsthetic agents (or methods) there are two holes instead of one as in the other sections. The inner row of holes is marked "Principal" and the outer row "Secondary." The purpose of the two rows of holes requires explanation.

The inner hole is encircled if that particular agent was the "principal" one employed. When the card is punched later this slot is made deeply to open both inner and outer holes. An agent used either as an adjuvant or just for induction purposes is denoted as a "Secondary" agent by the encirclement of only the appropriate outer hole. At punching this slot will be made only into the outer hole leaving the inner hole still intact. The anæsthetic agents used are inscribed at operation on the back of the card in the space allotted for this purpose, and the time of their introduction is marked on the chart itself together with the amount of oxygen added. From these data are determined the principal agent used and any secondary agents. In the event of more than three anæsthetic agents being employed for any case, after determining the principal agent the two most important of the remaining agents are selected as the secondary agents. Therefore, on any card one principal agent, and one only, is always en-

circled and two, one, or no secondary agents are also ringed as indicated by the findings on the back of the card.

An example will show how this composite group provides useful information. Consider two patients who had each been exposed to two anæsthetic agents, say, an intravenous one and nitrous oxide; the one patient receiving the intravenous anæsthetic for one hour and then nitrous oxide for ten minutes, whereas the other patient only received sufficient intravenous anæsthetic to abolish consciousness and thereafter one hour's nitrous oxide anæsthesia. Although both patients received the same agents their anæsthesias cannot usefully be regarded alike and the difference would be emphasized on the record card as follows:—In both instances the "Two agents used" hole would be encircled, but in the first instance I.V. would be encircled as the principal agent (requiring a deep slot later) and N_2O as the secondary (only the outer hole being slotted later), whereas in the second instance I.V. would be ringed as the secondary agent (and only the outer hole slotted) and N_2O as the principal (a deep slot to open both inner and outer holes being made when punching is done).

When sorting, the number of occasions on which a particular agent has been used—regardless as to whether alone or in combination (either as principal or secondary)—can be found by first needling the appropriate *outer* hole. Or again, by first needling the appropriate inner hole the number of times that particular agent has figured as the principal anæsthetic agent can be determined; then by needling the outer hole the number of times the same agent has been used as a secondary agent can be found. Or finally, after separating a pack of cards into three piles by first needling the number of agents used, straight single agents and the various combinations of principal and secondary agents can be worked out. In such fashion whatever information is required about the anæsthetic agents can be brought to light.

The anæsthetic agent designated by the word "Other" is encircled when some unspecified agent such as Ethylene, Trichlorethylene, Vinethene, etc., has been used.

Postoperative Complications

This group (O) is divided into subdivisions much like those in the preoperative complication group (D). A factor already present preoperatively should not be encircled as a postoperative complication unless the existing condition has been aggravated. Besides encircling the positive factors, details of any such together with other relevant comments on the patient's postoperative course and condition must be entered in the centre of the card in the space allotted.

Technical. This hole is encircled whenever a complication is directly due to a faulty anæsthetic technique. The following will serve as examples: trauma to lips, teeth, tongue or air passages resulting from the use of artificial airways, etc.; conjunctivitis, corneal abrasions, or burns of the skin from the spilling of volatile anæsthetic agents; sepsis due to injections for Regional Anæsthesia. Thrombosis of the vein or local complications following the use of intravenous anæsthesia would indicate the encirclement of this hole, whereas thrombosis elsewhere would call for the ringing of the appropriate C.V.S. complication hole. Nervous sequelæ following spinal anæsthesia should be entered against C.N.S. complications, and likewise an aspiration pneumonia against Respiratory complications. Although both these may be directly due to a faulty anæsthetic technique it will be found more helpful to allocate them as indicated.

Respiratory. The Major and Minor complications are similar to those enumerated under Section (D), with the exception of pulmonary tuberculosis, bronchiectasis, intrathoracic tumour, oral sepsis, rhinitis, bronchial asthma and emphysema. A minor respiratory complication should not be encircled postoperatively when a major respiratory complication has been recorded preoperatively.

The "1–4 Days" or the "Later" hole should also be encircled depending upon the time of onset of the respiratory complication after operation.

C.V.S. Signs of cardiac failure, persistent abnormal rhythms, serious embolus or thrombosis (except of the vein employed for intravenous anæsthesia), or peripheral circulatory failure rank as cardiovascular complications.

Which of the two holes provided should in such an event be encircled would depend on whether the time of onset was within twenty-four hours of operation or later.

C.N.S. In addition to the factors enumerated under this heading in Section "D" the presence of severe headache or nervous sequelæ following anæsthesia would indicate the encirclement of this hole.

G.U. The encircling of this hole is indicated by the occurrence of any of the complications, except sepsis, enumerated under this heading in Section "D."

Other. The development of jaundice, failure of liver function, or other unspecified major complication, indicates the encirclement of this hole.

None of Above. This hole should be slotted when none of the above-mentioned complications were presented. During sorting the needling of this hole furnishes a ready method of finding the patients who developed no postoperative complications with the possible exception of vomiting. One further needling through the "Vomit O" hole will sort out the patients who had no complications whatever.

Vomit. Encirclement of the appropriate hole indicates whether no nausea or vomiting occurred, or whether nausea and/or vomiting lasted for less than twelve, less than twenty-four, or for more than twenty-four hours.

The Last Side of the Card

Tracheo-bronchial Suction "P." This factor is encircled if the patient was intubated during the postoperative period and secretions aspirated from the tracheo-bronchial tree.[8]

Inhalation Therapy "Q." This factor is encircled if oxygen, carbon-dioxide, or helium was administered to the patient during the postoperative period.

Heading "R." This factor is encircled if the patient died before his discharge from hospital and the time of his death is shown by the encirclement of the appropriate hole in *Section "S."*

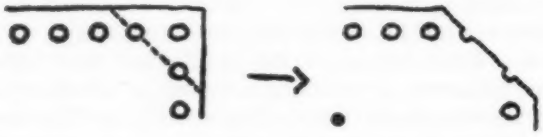
Heading "T." When this factor is encircled, it denotes that the cause of death was confirmed by autopsy.

Cause of Death "U." Six holes are devoted to this sec-

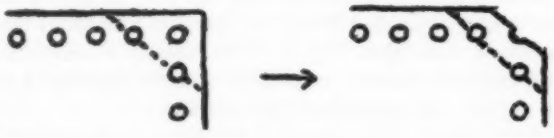
tion. "Anæsthesia" should be encircled not only when a patient dies during the induction of anæsthesia before the operation is commenced but also whenever direct responsibility can be attributed to the anæsthetic administration—e.g. death due to asphyxia. "Infection" should be encircled if a patient dies of peritonitis or an infective process anywhere in the body with the exception of the respiratory tract. Death from secondary hæmorrhage, since almost invariably due to sepsis, would indicate the ringing of the "Infection" hole, whereas death from primary or reactionary hæmorrhage would indicate encirclement of the "C.V.S." hole.

When all positive factors have been encircled and the relevant details filled in, the appropriate holes are slotted with punch or scissors. Then, and not till then, the corner marked with the diagonal line is snipped off and the card filed away.

In the ordinary way the corner should be cut off along the line so that the "one from the corner" holes are opened, thus:



When, however, a patient has had two or more anæsthetic administrations and therefore has two or more record cards referring to the *same* stay in hospital, the fact may be shown by cutting off only the corner hole of each card, thus:



Such cards can then be separated by needling either of the "one from the corner" holes which will now be left intact. For example, if a patient "burst his abdomen" after a laparotomy and subsequently died after its resuture, he would be recorded on each record card as having died. The desirability of being able to sort out the multiple anæsthesia

cases is necessary from the statistical point of view since it is obvious that one patient should only be recorded as having died once and yet the first operation *had* a fatal outcome.

SUMMARY

The record card described provides facilities for collecting and recording all relevant anæsthetic data as well as a method of assessing results statistically. This is all accomplished on the same card without having recourse to the use of a code book or sorting machine. In view of its simplicity and directness the method is particularly recommended to those who plan to file records for the first time.

I am much indebted to Col. B. C. Leech, R.C.A.M.C., and to Lieut-Col. R. M. Tovell, U.S.M.C., for many helpful suggestions during its preparation. The card has been designed to cover both military and civilian needs, and it is hoped to try and use the record in selected hospitals in the English, Canadian and United States Armies as well as in civilian practice. The cards are made by the Copeland-Chatterson Company and can be obtained from Messrs. A. Charles King Ltd., 27 Devonshire Street, London, W.1.

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THE ANÆSTHETIC RECORD

BY

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MOST hospitals and surgical clinics to-day use an anæsthetic record or chart for recording the condition of the patient during the progress of the operation, and afterwards in the ward. For some years the writer has made a hobby of collecting charts from various clinics, and it is obvious that considerable divergence of opinion exists with regard to the composition of an anæsthetic chart. Some anæsthetists prefer a simple form of chart consisting mainly of a graphic record of blood-pressure, pulse, and respiration; others favour a more elaborate record involving the use of codes and symbols, with provision for innumerable pre-operative and post-operative complications, and an operation chart which includes everything from the Basal Metabolic Rate to the anæsthetist's fee!

In drawing up an anæsthetic chart, a great deal depends upon the conditions under which the anæsthetist has to work. The punch card system[1] practised in America, and described in these pages, is too elaborate for use in this country; at any rate until each hospital has its own Department of Anæsthesia, staffed by whole-time specialist anæsthetists with technical and other facilities at present conspicuous by their absence. In this country the harassed anæsthetist not only has to cope with wartime difficulties, but often wastes a lot of time and energy in travelling from one hospital to another. Even before the war, the present writer sometimes visited as many as three or four hospitals in one day, and it would need a superman to keep complete records in such circumstances.

The present anæsthetic record and operation chart has been designed with strict regard to practical considerations, and represents an attempt to provide the maximum of essential

WARD C 3&4 **NEWCASTLE GENERAL HOSPITAL** DATE DEC. 9TH, 1942

ANÆSTHETIC RECORD

NAME R— W—. AGE 27 SEX M DIAGNOSIS SCIATICA (L.)

OPERATION LAMINECTOMY AND REMOVAL OF THICKENED LIG. SUBFLAVA. SURGEON MR ROWBOTHAM.

SUMMARY OF PRESENT ILLNESS

SCIATICA ON LEFT SIDE FOR 12 MONTHS.

PREVIOUS ANÆSTHETICS.

NONE.

GENERAL CONDITION

(GOOD.) FAIR. BAD. MORIBUND.

Temp. 97° Pulse 78 Resp. 18

B.P. Syst. 125 Diast. 70

Urine. S.G. 1014 Acid/Alk.

Sugar — Acetone —

Albumin —

Hæmoglobin ____ Blood Urea ____

Appearance HEALTHY.

Physique GOOD. Weight NORMAL.

Mental State PLACID.

Blood Group I. II. III. (IV.) — AB A B O

CARDIO-VASCULAR SYSTEM.	RESPIRATORY SYSTEM.
N.A.D.	N.A.D
Cardiac Decompensation. (Nil.) 1° 2° 3°	Cough — Sputum — Vital Capacity ____

PREMEDICATION Omnopon gr. ½ ÷ 3 & atropine gr. 1/100

Time given 1.30 p.m. Effect SLIGHT.

BASAL HYPNOTIC	INDUCTION	MAINTENANCE	TECHNIQUE
PENTOTHAL SODIUM 6 c.c.	N_2O + O_2 + ETHER	N_2O + O_2 + TRILENE (5 drachms)	PARTIAL REBREATHING
Rectal. Intravenous.	Smooth. Struggling.		Intubation ORAL.

GENERAL. LOCAL. REGIONAL. SPINAL.

Began 2.30 p.m. Ended 6.10 p.m.

Condition of Patient On leaving Theatre. GOOD. OPENED EYES.

ANÆSTHETIST DR AYRE.

information concerning the patient with the minimum of clerical labour: it is intended for routine use in hospital, including maxillo-facial, thoracic, neuro-surgical and other "special" clinics. It is compact ($9\frac{1}{2}$ inches by 8 inches) and contains sections for recording the pre-operative condition of the patient, anæsthetic agents and technique, a four-hour operation chart and a space for recording post-operative progress. Except for a few relatively common post-anæsthetic complications, long lists of hypothetical pathological conditions have been avoided. In the writer's opinion, such lists take up space which might be used to better advantage, and a summary of abnormal clinical findings with a short account of the relevant medical history conveys a far clearer picture, when reviewed at a later date. If it is desired to tabulate and classify the results of anæsthesia for hospital statistics, this can be done separately by means of the punch card or other system of classification, preferably by a specially trained clerical staff. The original record should then be filed with the other case records, or a micro-photograph may be taken in order to conserve storage space.

When filling in the anæsthetic record, it should be remembered that it is not the duty of the anæsthetist to make a complete clinical record of the case, and only those pathological conditions directly affecting the anæsthesia need be considered in detail. Broadly speaking, the special points which concern the anæsthetist are as follows:

(1) Anatomical conditions obstructing free respiration, e.g. nasal obstruction, adenoids and tonsils, enlargement of the thyroid gland, œdema of the glottis.

(2) Heart disease with symptoms of myocardial decompensation, especially when associated with mitral stenosis or aortic incompetence.

(3) Reduced vital capacity due to pulmonary disease, e.g. pneumothorax, empyema, bronchiectasis, lung abscess, tuberculosis, emphysema and other lung affections.

(4) Conditions interfering with the transport of oxygen by the blood, e.g. anæmia, blood diseases, hæmorrhage or shock.

(5) Acidosis and ketosis due to starvation, diabetes or nephritis.

(6) Alkalosis and dehydration resulting from prolonged vomiting, e.g. acute intestinal obstruction, pyloric stenosis, cerebal tumour.

(7) Toxæmia or septicæmia complicating acute surgical conditions, e.g. cellulitis, osteomyelitis, peritonitis.

(8) Lowered vitality due to malignant cachexia, chronic sepsis or general debility.

(9) Impairment of hepatic or renal function.

(10) Injury or disease of the central nervous system.

Theoretically the basal metabolic rate should be included in the foregoing list, but the technical difficulties render this investigation impracticable except in special cases.

On many anæsthetic charts the anæsthetic or operative "risk" is indicated by symbols or letters, such as A, B, C, D, DD, and so on. In a recent paper by Adams and Lundy[2] a classification of operative risk is suggested on the following lines: "Grade I, patients in such good physical condition that they will probably tolerate any anæsthetic agent well; grade 2, cases of so-called average risk, in which the risk of the operation is greater than the risk of the anæsthesia; grade 3, patients for whom the anæsthetic agent must be selected with care, since, owing to pathological conditions, the risk of the anæsthesia is as great or greater than the risk of the operation; and grade 4, patients who are in such serious physical condition that the use of any anæsthetic agent is dangerous." In the writer's chart the words "good," "fair," "bad" and "moribund" correspond to these four categories.

The rest of the anæsthetic record needs little comment. In order to avoid overcrowding the operation chart, separate spaces have been provided for recording the anæsthetic agents used and the depth of surgical anæsthesia. A line drawn at the appropriate time interval represents the duration of each anæsthetic agent administered during the operation, above the lines figures may be inserted indicating the minute volume in litres, or the percentage in the gaseous mixture. A blank space has been left for ether, trichlorethylene, chloroform or other supplementary anæsthetic agent. For charting the depth of anæsthesia figures are written representing the various planes of the third stage according

to the classification of Guedel, or a line may be drawn descending nearer to the base line as the anæsthesia deepens.

In addition to the functions already mentioned, the anæsthetic record plays an important part in the practical instruction of medical students: the latter should preferably work in pairs, one administering the anæsthetic and the other filling in the chart. In this way students can see for themselves the physiological effects of anæsthetic overdose, respiratory obstruction, shock, hæmorrhage and other complications arising during the course of the operation, and learn to appreciate the necessity for looking after the general condition of the patient while administering the anæsthetic.

In conclusion, it is only fair to mention that in designing the foregoing anæsthetic record considerable reference has been made to records and charts used in other hospitals. It has been printed for the Newcastle General Hospital by Messrs. Andrew Reid and Co., Newcastle-upon-Tyne.

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ABSTRACTS

"Fate of procaine after subarachnoid injection." GOLDBERG, KOSTER and WARSHAW in *Archive of Surgery*, January, 1943.

THE authors developed a technique which enabled them to trace the course of the drug and determine what changes it underwent after insertion into the spinal canal. Their conclusions were:

(1) Procaine remains unchanged while within the subarachnoid space. The fall in concentration which is responsible for the wearing off of anæsthesia is due to vascular absorption.

(2) Once in the blood-stream procaine is rapidly hydrolysed (detoxified by an enzyme).

(3) There is also an enzyme which acelytates the free amino group.

(4) At no time is there any appreciable trace of procaine in the blood; hence the cause of various "toxic" effects which have been attributed to this must be sought elsewhere.

(5) The products of detoxication leave the blood-stream rapidly until equilibrium is approached between the blood and all the other tissues.

(6) Nearly all the injected procaine is excreted in the urine in the form of products of detoxication. Detoxication takes place in the liver. Gravitational displacement of the injected solution is negligible.

"Two Thousand cases of Nupercaine Spinal Anæsthesia." R. S. VERSTER, F.R.C.S. (Edin.) *South African Medical Journal*, March 27, 1943, p. 89.

IN a series of 2,000 operations under spinal anæsthesia there was one death. The hypobasic solution Nupercaine 1/1500 was administered according to the Howard-Jones technique. The level of anæsthesia was controlled by the amount of Nupercaine solution injected into the C.S.F.

The anæsthetic solution was warmed before use, about 10 drops C.S.F. withdrawn before injection to ascertain that the spinal needle was correctly placed, and the operating table tilted into 10°–15° Trendelenburg position, only after 10 minutes when the patient was rolled on to his back. The usual contra-indications to spinal anæsthesia were observed, intestinal obstruction was not included. During operation the muscular relaxation was complete, but the fall of blood pressure which occured after 30 minutes was not controlled by the administration of Ephedrine in many instances. Post-operative headache occurred in 25 per cent of patients, and in some cases lasted from 7 to 10 days.

This series was published to demonstrate the value of spinal anæsthesia in districts where no specialist anæsthetist is available and where the results of general anæsthesia administered by the newly qualified medical officer or general practitioner are unsatisfactory. It is recommended that under these conditions spinal anæsthesia should be used frequently or not at all and that the surgeon should give the anæsthetic, he is then responsible for its induction and conduction, and there is no division of responsibility which in some instances has resulted in tragedy.

"Continuous Caudal Anæsthesia during Labour and Delivery." ROBERT A. HINGSON, M.D. and WALDO B. EDWARDS, M.D. in *Anæsthesia and Analgesia,* November-December, 1942, p. 301.

CONTINUOUS caudal anæsthesia was used in a series of 65 cases of which 52 were primipara and 13 multipara the average duration of anæsthesia in this series was 6½ hours.

The anæsthesia solution found most satisfactory was 1½ per cent metycaine in normal saline. In no instance was the fall of blood-pressure alarming nor were there any toxic reactions to the drug. The foetal heart was unaffected—both rate and rhythm remained constant and without exception the babies cried vigorously at birth.

The extra-dural injection of a local anæsthetic drug provided relief from all labour pains within 5 to 10 minutes of time of injection without influencing the course of the labour.

Preliminary sedation was rarely necessary. The anæsthetic solution was injected with the patient in the knee-elbow position or lying on her side, flexed as for spinal anæsthesia. The needle was fixed in position with adhesive tape and connected by 2 feet of seven-eighth inch rubber tubing to a flask containing the anæsthetic solution and to a 5 c.c. syringe. The initial dose of 30 c.c. of $1\frac{1}{2}$ per cent solution of metycaine was injected slowly into the sacral canal at an even rate over 2 minutes, and the patient placed in the lithotomy position for delivery. The anæsthetic was continued by injecting fractional doses of the anæsthetic solution 20 c.c. every 30–40 minutes, and was found satisfactory in most cases. The complications included broken needles in 4 cases, unilateral anæsthesia in 4 cases and occasional transient backache and headache.

With this technique the perineal musculature is completely relaxed, the bladder becomes distended, the cervix dilates rapidly and the uterus maintains its tone after delivery. Post-natal examination of patients six weeks after delivery showed no ill effects following continuous caudal anæsthesia.

REVIEW

"Regional Anæsthesia for Intra Abdominal Surgery." By NORMAN R. JAMES. Published by Messrs. J. & A. Churchill Ltd., London. p. 240. Price 6*s*.

REGIONAL anæsthesia has not been popular in this country in the past but the publication of this book may awaken renewed interest in the subject.

Dr. Norman James is of the opinion that regional anæsthesia for intra-abdominal operations is the most satisfactory of all present forms of anæsthesia for patient, surgeon and anæsthetist and believes it is neither difficult to learn nor dangerous in the hands of the beginner.

The general technique, which may be modified for certain operations and for which very little special equipment is necessary, consists of blocking the lower seven thoracic nerves on both sides and performing bi-lateral posterior splanchnic block. Anethaine or amethecaine hydrochloride though more toxic than cocaine or procaine when used in a 1/1000 solution for the thoracic block and a 1/2000 solution for the splanchnic block, produce anæsthesia which lasts over 3 hours, and seldom produce toxic symptoms in a patient if overdosage is avoided.

If supplementary narcosis is considered advisable it is administered either in the form of a light general anæsthetic or a strong hypnotic—large doses of morphia or Omnopon given intravenously have proved satisfactory. Complete relaxation of the abdominal muscles is produced by the thoracic block, and operative shock reduced to a minimum by the bi-lateral splanchnic block, performed according to the method of Kappis. It is of interest to note that in a severely shocked patient when the blood-pressure is low the fall of blood-pressure which always follows splanchnic block does not seem to affect the general condition of the patient. Oxygen therapy, for which a B.L.B. mask is used, is of immense value in these patients as well as in those showing

toxic reactions to anethaine or in respiratory depression from other causes.

There are many advantages in regional anæsthesia, notably the complete abdominal muscular relaxation, satisfactory condition of the patient, both during and after operation, and the reduction of shock to a minimum. It can be used in all non-emergency and emergency intra-abdominal operations, including war casualties.

Dr. James has written a clear account of this technique and its many advantages, but has not discussed the disadvantages or made mention of any contra indications. The fall of blood-pressure following splanchnic block has been considered a disadvantage by many in the past, and fatal results are not unknown.

In patients suffering from penetrating wounds of the abdomen, which occur frequently in war casualties, it is often impossible and even dangerous to move them into a position suitable for performing thoracic or splanchnic blocks. This point has not been considered by the author when recommending this type of patient as eminently suitable for regional anæsthesia.

The present effective methods of anti-shock treatment such as large quantities of plasma, blood, etc., given intravenously, make general anæsthesia safe in these patients if reasonable skill is used, and it is not unreasonable to assume in the light of recent experience, that a patient who is fit for an operation under a local anæsthetic will stand a general anæsthetic equally well.

The time factor in regional anæsthesia may also be of importance in these days when staff is limited; the practice of leaving a shocked patient, whether under a regional or general anæsthetic, to the care of an inexperienced person, is not devoid of serious risk.

Dr. James has made regional anæsthesia sound, safe, easy and reliable, in fact the ideal anæsthetic for intra-abdominal operations. When further data are available opinions may differ on this subject, but it may prove to be a definite advance in modern anæsthetic methods.

CORRESPONDENCE

Anæsthesia and the Subconscious Mind.

DEAR SIR—On reading Dr. Hadfield's article in the January 1943 issue of the *British Journal of Anæsthesia* many thoughts came into my mind and from these I jotted down the following, which might be of interest.

Among what might be termed the permanent urges of man are the will to live and the attempt to understand life. From time to time these are subordinated to more passionate desires which are largely of a temporary nature. Thoughts may be repressed into the subconsciousness for many reasons but there are two reasons which taken widely include all other. These are, firstly, that the subject is too awful to contemplate, or, secondly, that the mind fails to find any chance of success and gives up the unequal struggle just as a fourth form schoolboy would have to give up a problem in integral calculus.

When the subconscious mind asserts itself because the conscious or "controlled" mind has been eliminated these questions are apt to come forward. Prevailing emotions suppressed before anæsthesia may arise in the recovery state; the slobbering youth may make love; a man may weep and say he wished he had treated his wife better. I had one patient who, on coming round from nitrous oxide, stamped his foot against the footpiece of the chair, seized the arms, yelled, and finally relaxed, saying "I can't hold the b—— thing." On recovery he told us he had been worried for weeks because a speed-recorder had been fitted to his 10-ton lorry so that the tale would be told when he returned. Those who have not such present worries may have their minds engaged by what we have termed the more permanent urges.

When working with the late S. R. Wilson and taking nitrous oxide for experimental purposes I often, if not usually, awoke to see the "solution of life" slip from my mind and the immediate reaction was to seize the machine

and give myself some more to recapture this priceless solution before it was too late. This is a most dangerous turn of mind. S. R. W. was greatly interested in phenomena of all kinds and he was certain that he was on the verge of a great discovery. He wrote hundreds of sheets of paper—subjective symptoms and thoughts jotted down as he became influenced by nitrous oxide. Twice when I was in attendance we nearly came to blows and once he accused me of having "frustrated him from making the most important discovery of life." He finally killed himself with nitrous oxide.

The only constant recording through all "S. R.'s" papers was Xanthropy in the early stages.

Dr. Hadfield's patient referred to the revolving and advancing retreating disc—an optical effect. I myself discovered the solution to life and infinity under nitrous oxide. It consisted of a nucleus of light—a star—which advanced or enlarged, threw off its foremost portions which immediately divided by equal fission into two and these pieces—somehow representing our mortal selves—shot off into space towards me and past my ears to disappear into nothing. When I realized that infinity, which as a student I wrote so often of, was nothing more or less than this endless amœba-like fission, I roared with laughter. I heard the laughter echo from cavern to cavern. The light went out, there was deathly silence, for the fraction of a second I was afraid. The dentist looked at me with a very puzzled expression.

I think there is little to be gained in trying to capture these subconscious and fleeting thoughts or impulses and as I have remarked I know from my own experience that it is dangerous to allow oneself to be led on in this hopeless quest. The frequency of the recording of some optical phenomenon under nitrous oxide is a reminder that blindness occurred in several of the cases of asphyxia recorded by Corville.

The more puzzling dream is the prophetic one. I was giving gas one Saturday afternoon to a man who regretted missing the football match and as he was coming round he shouted "goal." He was very excited and told us that the "Cobblers," Northampton Third Division football team,

had beaten Huddersfield, the League champions in the "cup." This was 2.0 p.m. The match was concluded later as prophesied by my patient, complete with the names of those who scored goals.

Yours etc.,

F. F. WADDY

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